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(54) Title: A COMPOSITE MATERIAL

(57) Abstract

A composite material comprises cement, an inorganic filler and reinforcing fibres. The reinforcing fibres are separated into individual filaments by a surfactant during manufacture and the fibres have a length less than 10mm.

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A COMPOSITE MATERIAL

The invention relates to a composite material and especially, a composite material suitable for molding into a panel.

Synthetic panels are known which are used in place of wood panels, for example, for external panelling and internal partitions in buildings. These conventional synthetic panels include cement boards, gypsum boards, calcium silicate boards, phenolic boards etc.

In accordance with a first aspect of the present invention, a composite material comprises cement and reinforcing fibres, the reinforcing fibres being separated into filaments and having a length less than 10mm.

In accordance with a second aspect of the present invention, a method of manufacturing a composite material comprises forming a first mixture comprising water and cement; adding reinforcing fibres and a surfactant to the first mixture to form a final mixture; generating foaming of the final mixture; introducing the final mixture into a mold; permitting the final mixture to harden within the mold; and subsequently removing the hardened composite material from the mold.

An advantage of the invention is that the use of a

surfactant separates the reinforcing fibres into finer filaments which promotes increased strength of the composite material.

The reinforcing fibres in the second aspect of the invention may be less than 10mm.

Typically, the reinforcing fibres have a length of 5mm to 9mm and preferably, a length of 6mm.

Typically, the composite material may further comprise an inorganic filler. Typically, the first mixture further comprises an inorganic filler.

Preferably, the inorganic filler comprises a clay, which typically comprises kaolin clay.

Typically, the reinforcing fibres comprise glass fibres and/or polyacrylonitrile fibres.

Preferably, the cement comprises white cement. Alternatively, the cement may be portland cement. White cement has the advantage that colouring may be added to the mixture to colour the composite material more easily than other cements. Portland cement has the advantage that it is less expensive than white cement.

Preferably, the method further comprises the step of adding

a cure accelerator before the final mixture is introduced into the mold. The addition of a cure accelerator aids hardening of the composite material.

Preferably, the cure accelerator is added to the final mixture during foaming of the final mixture and prior to introducing the mixture into the mold. Typically, the cure accelerator may comprise calcium chloride.

Typically, the composite product may comprise additives, such as plasticises and cement strengtheners.

Typically, the method may further comprises adding other ingredients, such as, plasticises, flow promoters and cement strengtheners.

Typically, the method further comprises mixing together the reinforcing fibres, the surfactant and water to form a second mixture and subsequently mixing the first and the second mixtures together to form the final mixture.

Preferably, the surfactant comprises a non-ionic surfactant, such as an ethoxylated phenol. For example, suitable surfactants may be Empilan NP 9 or Empilan NP 6 as manufactured by Albright & Wilson.

Preferably, the composite material is moulded into a substantially planar panel and, typically, the mold is

orientated such that the planar surfaces of the panel are substantially horizontal during hardening.

However, alternatively, it is possible that the mold may be orientated such that the planar surfaces of the panel are substantially vertical during hardening.

Typically, after manufacturing the composite material, the composite material may be laminated to increase the shear strength of the composite material. Typical laminating materials may include plastics, veneers, thin metal sheets or any other suitable materials.

An example of a composite material and a method of manufacturing a composite material in accordance with the invention will now be described.

0.18kg of glass fibres and 0.18kg of polyacrylonitrile fibres were mixed with 1.3kg of non-ionic ethoxylated phenol surfactants. The non-ionic ethoxylated phenol surfactants comprised a mixture of Empilan NP 9 and Empilan NP 6 as manufactured by Albright & Wilson. The action of the surfactant on the fibres is to cause the fibres to separate into filaments and disperse as filaments within the fibre/surfactant mixture. About 2.5kg of water can be added to assist dispersion and mixing.

35kg of white cement was then mixed with 5kg of kaolin clay

and about 20kg of water. After the cement, clay and water mixture has been homogenised, the fibre and surfactant mixture is added to the cement, clay and water mixture and the resulting mixture homogenised with a multiblade high speed disperser.

Due to the presence of the surfactant, the resulting mixture foams and air is entrained within the mixture. By controlling the ethoxylation of the surfactant, the amount of water and the time of agitation of the mixture, the degree of forming of the mixture can be controlled. For example, a surfactant having a high ethoxylation will generate more forming and therefore produce a product with a relatively lower density. A surfactant with a low ethoxylation will generate less forming and therefore produce a product with a relatively high density. An example of a non-ionic ethoxylated phenol surfactant with a high ethoxylation is Empilan NP9 and an example of a non-ironic ethoxylated phenol surfactant having a low ethoxylation is Empilan NP6. In addition, densities in between can be achieved by mixing appropriate ratios of Empilan NP 6 with Empilan NP 9 to achieve the desired density.

While the mixture is undergoing foaming, cure accelerations, flow promoters and cement strengtheners are added. When a suitable degree of foaming is achieved the mixture is poured into molds. Typically, the molds are

horizontal open cast molds with the depth of the mold ranging from 8mm to approximately 30mm with a length of approximately 2.4m and a width of approximately 1.2m. If desired, patterns can be formed in the surface of the mold to mold a textured surface on one side of the cured product. Marbelising effects may be produced by the addition of colouring or dies to the mixture just prior to pouring of the mixture into the molds. Alternatively, the molds be orientated vertically such that the opening of the mold through which the mixture is introduced defines an edge of the cured product.

Typically, the mixture is left to cure in a thermally insulated environment until it has hardened which may be, for example, 12 to 48 hours. The composite material is then removed from the mold.

The composite material was found to have good thermal insulation, sound insulation and fire resistant property.

The composite material was also found to have good dimensional stability in humid and temperature fluctuating conditions. Under water immersion conditions the composite material was found to take up 50% of its weight in water but with a negligible change in external dimensions. The absorbed water was then released under drying out conditions.

In addition, the composite material has an alkaline surface pH of approximately 12. Therefore, being inorganic and alkaline, the composite material resists attack by insects and organisms and has resistance to mold growth. In addition, the composite material has no toxic vapour emission during service.

The composite material was found to be workable in a similar manner to wood and may be sawn, drilled, screwed and air stapled with standard wood working tools.

The composite material is particularly suitable for use in the form of a board or panel. In addition, the composite material may be laminated to increase the strength of the board or panel. Typical laminates include plastics, veneers, thin metal sheets, conventional high pressure laminates and melamine films. The finished board or panel may be used as raised flooring, wall panels, ceiling panels, fire partitions or for other construction uses. The required density of the composite material may be varied by choosing the surfactant or mixture of surfactants, water and time appropriately to control the foaming during mixing. Other applications of the composite material include a substitute for ceramic tiles, fatias, wall cladding and linings, partitions, dry walls, ceiling panels, toilet and shower cubicles, fire and/or sound insulating partitions.

CLAIMS

1. A composite material comprising cement and reinforcing fibres, the reinforcing fibres being separated into filaments and having a length less than 10mm.

2. A composite material according to claim 1, and further comprising filler.

3. A composite material according to claim 2, wherein the filler comprises an inorganic filler.

4. A composite material according to claim 3, wherein the inorganic filler comprises a clay.

5. A composite material according to claim 4, wherein the clay comprises kaolin clay.

6. A composite material according to any of the preceding claims, wherein the reinforcing fibres comprise glass fibres.

7. A composite material according to any of the preceding claims, wherein the reinforcing fibres comprise polyacrylonitrile fibres.

8. A composite material according to any of the preceding claims, wherein the cement comprises white cement.

9. A composite material according to any of the preceding claims, wherein the reinforcing fibres have a length of between 5mm and 9mm.

10. A composite material according to claim 9, wherein the reinforcing fibres have a length of approximately 6mm.

11. A method of manufacturing a composite material comprises forming a first mixture comprising water and cement; adding reinforcing fibres and a surfactant to the first mixture to form a final mixture; generating foaming of the final mixture; introducing the final mixture into a mold; permitting the final mixture to harden within the mold; and subsequently removing the hardened composite material from the mold.

12. A method according to claim 11, further comprising mixing together the reinforcing fibres, the surfactant and water to form a second mixture and subsequently mixing the first and the second mixtures together to form the final mixture.

13. A method according to claim 11 or claim 12, further comprising adding a cure accelerator before the final mixture is introduced into the mold.

14. A method according to claim 13, wherein the cure accelerator is added to the final mixture during foaming of

the mixture.

15. A method according to claim 13 or claim 14, wherein the cure accelerator comprises calcium chloride.

16. A method according to any of claims 11 to 15, wherein the surfactant comprises a non-ionic surfactant.

17. A method according to claim 16, wherein the non-ionic surfactant comprises an ethoxylated phenol.

18. A method according to any of claims 11 to 17, wherein the composite material is molded into substantially planar panels.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG 98/00048

A. CLASSIFICATION OF SUBJECT MATTER

IPC[6]: C 04 B 14/38, 16/06, 28/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[6]: C 04 B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0 120 800 B1 (SOCIETÉ DES ANCIENS ETABLISSEMENTS LOUDE FRÉRES) 13 January 1988 (13.01.88), claims.	1-18

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

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